REPORT OF TWENTY-EIGHTH MEETING OF THE MICHIGAN SCHOOLMASTERS' CLUB

THE twenty-eighth meeting of the Michigan Schoolmasters' Club opened its sessions at Ann Arbor, Friday, April 2, 1897. The day sessions Friday were given to the conferences in Latin and Greek, English, history, mathematics, physics, biological sciences, reports of which are given briefly with a few of the papers on the more important topics. Friday evening Professor Paul H. Hanus, of Harvard University, delivered an address on, "What should the Modern Secondary School Aim to Accomplish?" This has already appeared in *The Review*. At the general sessions of the club, Saturday, Professor Hanus read a paper, which was discussed by Professor Klimcksel, of Hope College, on "Preparation of the High-School Teacher of Mathematics." Mrs. Florence Milner, of the Grand Rapids High School, followed with a paper on, "What Ought the Study of Mathematics to Contribute to the Education of the High-School Pupil?" Principal E. T. Austin, of Owosso, discussed the topic further. The session closed with a paper on "The Teaching of Economics in the Secondary School," by Dr. F. H. Dixon, of Michigan University, after which a discussion was participated in by Professor H. C. Adams, of Michigan University; Principal E. V. Robinson, of Muskegon; Principal J. E. Lautner, of Cadillac, and Professor B. A. Hinsdale, of Michigan University. These papers, with an outline of discussions, appear elsewhere.

E. C. GODDARD
Secretary

HISTORICAL CONFERENCE

In the historical conference the chief subject of discussion was the question: "Can American history be taught in all the courses in the high school?" The subject was opened by Professor McLaughlin, who pointed out that it was desirable to consider the question from the practical point of view and from the standpoint of the programme; is there place in the programme for a semester's work in American history? Principals Bliss, of Detroit; Hartwell, of Kalamazoo; Warriner, of Saginaw; Robinson, of Muskegon, and others, took part in the discussion. All expressed interest in the

subject, and all seemed to agree that, if the preparation in Greek required only two years, the university requirements could be met, and American history be taught in addition. There were some differences of opinion concerning the time that could be allotted the subject under present conditions, and the method that could be used.

After the conference had discussed this matter for a time, Professor Hudson explained why a year's work in English history had been included in the new requirements for admission, one of the reasons being that by studying the subject for a year a student could complete in the high school the elementary work that is now done in college.

Mr. Warriner's paper is given as an interesting contribution to the subject first discussed by the conference (see p. 101).

REPORT OF PHYSICAL CONFERENCE

The physical conference of the Schoolmaster's Club assembled in the physical laboratory at 10:30. Professor Carhart of the university began the programme by exhibiting two synchronous pendulums, illustrating very nicely sympathetic vibrations. He was followed by Mr. Randall, of Saginaw, who presented some very interesting pieces of apparatus for showing the magnetic field around a wire carrying a current. By using a large number of turns of wire, he was able to produce, with a single Grenet cell, a strong magnetic field. The apparatus would be especially useful for laboratory work.

The afternoon meeting was opened by Professor E. A. Strong of The State Normal School, president of conference, with a helpful paper on laboratory administration. A brief outline is given because the question is of interest to science teachers.

A SMALL school is not necessarily an inferior school. Many of the smaller, or "non-diploma," high schools in our state are taught with intelligence and power. In one or two subjects they are often superior to the "diploma" schools. But they have no tradition of excellence, no steadiness, no continuity, and hence can give no assurances for the future. In a few of these schools the instruction in physics is sound and strong year after year; in others it is occasionally good; in many it is always deplorably weak. Of the 350 or so 10-grade, 11-grade, and 12-grade high schools in the state more than 60 per cent. make some effort to have a demonstrative course, and fully one-half of this number attempt to add a laboratory course in physics or chemistry, or both. The difficulties in the way of this laboratory course are so great in a small community that many of these schools have apparently weakened their work by the introduction of laboratory physics. Not only have their graduates less information than formerly concerning physical fact and law, but their ideas are more crude and confused. They should not, therefore, abandon this

laboratory work, but they should be helped in the effort to integrate and strengthen it.

A very common evil is a want of any proper connection or relation between the demonstrative and the laboratory work. Whether two books are used or only one they seem to be two separate subjects.

The physics teacher is loaded down with work. Usually he has from six to ten classes to teach, and often as many subjects as classes. If any laboratory work is attempted by pupils, except at the regular physics period, it must be without the presence of the teacher or outside school hours. This section of the club might very properly appoint a committee to consider what rights should be accorded this subject, and the teacher of this subject, upon the school programme.

More and more there is specialization of duties in the corps of teachers of even the smaller schools, and the physical instruction has profited by this tendency. In our own state the most common combination of subjects is the sciences, so-called, including physics, chemistry, astronomy, physiology, botany, zoölogy and physical geography or geology, or both. The next most common combination is physics, chemistry, algebra, and geometry; physics, chemistry, and Latin is not infrequent; also physics, chemistry, German, and history.

Physics is taught as a leading subject by the principal as often as any subject except Latin, though English and mathematics occupy this position hardly less frequently.

A change in the principalship often, perhaps usually, results in a change in the policy of the school, and the smaller the community the less power school officers and school tradition have to resist this tendency. The sciences suffer especially from this change of policy, as the slow accumulations of scientific material are rapidly dissipated in an uncongenial atmosphere.

The notebook is often used so as to stand in the way of good work. Far too little is made of the direct record of personal observations taken at the moment, and far too much of these results as elaborated and depicted in elegant form during leisure hours.

Laboratory fittings and apparatus are hard to get and easy to lose in many schools; mainly hard to get because easy to lose. The state as a whole expends a reasonable amount annually for maps, charts, apparatus and material, but much is unwisely purchased and more is ill cared for.

School boards, with the reluctant consent of the teacher, make many unwise purchases. The main purchases of material for school use made in many towns are of such maps, charts, cyclopædias, astronomical lanterns, tellurions, orseries, air-pumps, barometers, etc., as are pushed upon them by selling agents. Teachers also order expensive luxuries; apparatus without accessories, and so useless, or pieces having little relation to the actual work of the school.

Apparatus like the above is naturally not cared for and soon gets into the waste-heap. In this way a habit of treating carelessly even such pieces as have some vital relation to instruction is formed. In many schools the annual loss of material from careless handling, from improper use, from neglect, and from unfavorable conditions for use, is excessive. Especially is the want of storerooms, cases, cupboards, etc., a source of waste, loss, and "wear and tear" of scientific material. This section of the club would do well to publish leaflets or circulars calling attention to this matter, and urging that suitable provision for laboratory work be made at the time of the erection of the high-school building.

Teachers do not keep up their reading. The number of foreign and American scientific periodicals taken in the state has never been large, and would not seem to be increasing. Small salaries and little time for reading are usually alleged as the cause for this state of things, but it is much to be regretted.

Superintendent Bemis, of Ionia, led the discussion on the paper and brought out some of the difficulties the teacher of science in the small school has to contend with. Following the general discussion, Professor Carhart gave some Thompson repulsion experiments with alternating currents. A heavy ring of copper was repulsed with such force as to cause it seemingly to overcome gravitation and to hang in the air. The rapid alternations of the current, 280 times a second, caused the ring to become too warm to handle with comfort. An incandescent lamp was made to light, though only held above the coils. Dr. St. John, of the university, next gave some "experiments with the Hertzian waves." He showed the phenomena of resonance, of reflection and of polarization, and finally measured the wave-length. This is the first time these experiments have been performed in Michigan. Mr. Hawkes, of Ann Arbor High School, closed the programme. He exhibited a "modification of Atwood's machine." It makes the machine self-recording, and from the data given, it seems to be a real improvement over the old form of Atwoods'.

At the business meeting, Mr. C. F. Adams, of Detroit High School, was made president of the conference, and Mr. F. A. Osborn, of Olivet College, secretary. The following motion was carried: "That a committee be appointed to ascertain the opinions of physics' teachers in the state concerning the total amount of time needed for the recitation and laboratory work in the subject, and to report a reasonable medium demand."

MATHEMATICS CONFERENCE

OUTLINE OF A PAPER ON THE "PRINCIPLE OF CONTINUITY," BY MISS IDA L. BROWN, YPSILANTI

MISS BROWN called attention to the contributions of Kepler, Roscovich, Poncelet, and Desargues in originating and perfecting the theory; its

remarkable growth in importance during the present century in France, Italy, Germany, England, and our own country; its utility in adding to the interest, awakening the spirit of discovery, and giving a broader view to the whole subject of geometry. The essential features of the theory were illustrated.

Magnitudes, real and imaginary, positive and negative, were treated in the solutions of propositions; all parallel lines were shown to have a common point of intersection at infinity, while a straight line was regarded as a circle with its center at infinity. Propositions, impossible of solution by pure geometry, were solved by algebraical method, and the principle of continuity was applied to show how the elegance of the one method might be combined with the generality of the other.

One of the propositions taken up was that regarding the relation which exists between the similar polygons constructed upon the sides of any triangle, and from this were derived all the special cases growing out of this general proposition.

A DISCUSSION OF THE STUDY OF MATHEMATICS, BY PRINCIPAL E. T. AUSTIN, OWASSO

It is quite generally considered, I think, by psychologists that when any mind characteristic is developed and the nerve cells in some part of the brain are more or less specialized, that this part undergoes a certain change which results in its differentiation. The degree of differentiation depends upon the degree of development of the nerve cells of that part. To quote from Professor Halleck: "Each sensory nerve area exists for the purpose of receiving the proper stimuli from the external world. These centers must remain comparatively undeveloped if they are not properly exercised." Again he says: "An adult may be approximately defined as the sum of his youthful nerve reactions, which tend to perpetuate themselves. Youthful nerve cells are like freshly mixed plaster of paris, and, like it, they soon lose their plasticity." It is a fact known to physical science that when a mass of metal in a car wheel or cannon has been subjected to oft-repeated shocks, the molecules rearrange themselves to conform to the changed conditions. In the same way brain cells change under repeated shocks or stimuli from without. The period when the brain cells readily respond to outside stimuli ends before the age of twenty-five.

If we accept as valid these conclusions of the psychologist, and it seems to me we must, we have forced upon our consideration problems of considerable magnitude, some of which must be worked out by the secondary-school teacher, since he deals with the student at the time when his mind is the most plastic. We owe it to him as well as to the community that we equip him to the best advantage at this time, for we may do any thing that is rea-

sonable with his mind. All subsequent knowledge must be built upon this youthful foundation.

At the high-school age the pupil will not have passed the stage of his life in which memory is stronger than any of the other mental characteristics, and up to the time of entering the high school it is stronger than it will be at a later period. Then up to this time his study of mathematics should have been with the idea of acquiring the fundamentals, rather than with the idea of training the reasoning powers. It would seem better to consider the elements of algebra and concrete geometry recommended by the Committee of Ten than to master arithmetic. Should he stop going to school at the end of the eighth grade, he will have gained much useful knowledge, and should he enter the high school, he is in possession of a part of the routine or mechanical work. Have him memorize some of the working principles of algebra, know how to bisect lines and angles, construct perpendiculars, and understand some of the properties of equality and similarity. Much of the mensuration of arithmetic might be taught as concrete geometry. It will be seen that up to this time mathematics have contributed most to the practical side of the pupil's education, and at a time when it can be done to the best advantage.

During the first and second years in the high school the acquiring of useful knowledge should become a secondary matter. At this period memory is still active and will find many opportunities for its exercise. It is now time to present mathematics in a form that admits of systematic demonstration. This purpose of mathematics should come more and more into prominence as the work goes on. We are to bear in mind this is the only chance the large majority will ever have for training their powers of logical reasoning. A student trained in following a mathematical deduction and with suitable exercises has worked out for himself a sound logical course of reasoning, has gained more power than mere knowledge can ever give. It is the power gained by this rigorous course in logic that will be so helpful when the everyday problems come to him for solution. Too often pupils are led to think that the solution of exercises is the chief end of high-school mathematics, but they should early be led to understand that the main object is an insight into the meaning of the processes involved, and the training in logic. The educational value of mathematics consists less in the amount done than in the way it is done.

As a third contribution of mathematics to the education of the high-school pupil I mention the power of generalization. One is only to remember the impetus given to mathematics by the discovering, in 1540, by Vieta, that when symbols or general characters are used the solution becomes general for all problems of that class. The moment this is fully comprehended by the pupil he is lifted out of the region of particulars into the region of universal truths. A certain bank cashier, when asked by me to

state what mathematics had contributed to his education, replied: "The power to generalize. If it be a problem in computation, I put it into the form of a general equation, apply the usual laws, and know at once I have the solution for the special case. A moment's thought will reveal the extent to which we use the power of summing up or generalizing." In geometry and algebra we have two ways by which this important mind characteristic may be developed. These mathematical subjects have this advantage that when the conclusions are once obtained there are no misgivings that they may prove false at another time.

This consideration brings me to still a fourth contribution of mathematics to the pupil's education — a feeling of absolute certainty and confidence. With what assurance the pupil moves from data to conclusion, from the known to the unknown! Well he knows he is making use of the greatest mental force of which the human mind is capable; and he must know that these are the methods by which at least approximate certitude is attainable in other departments of knowledge. In fact, I deem this so important that I take every possible occasion to impress it upon my pupils. This feeling of certainty in mathematical conclusions has a direct influence on the formation of habits of right thinking, a point well brought out in the first paper.

Finally, it may seem that the study of algebra and geometry has no relation to the welfare of the community. The equation with its tangle of symbolized quantities and geometry with its lines, surfaces, and solids may seem to have nothing to do with everyday life. When the boys and girls have worked out the equations and determined the relations of the geometrical concepts, what will it avail them or the business world? Notwithstanding that the numbers are few who are made broader, deeper, and better by this study, experience shows that the numbers are on the increase and that mathematical study has not lost ground. Through the few, but in a changed form, will the world at large be made better, not by algebra and geometry directly, but by the increased mental power of men and women elevated and made stronger by mathematics.

DISCUSSION OF "METHODS OF ATTACK IN GEOMETRY," BY MARY E. TRUEBLOOD, SAGINAW, E. S. HIGH SCHOOL

I well remember the time when I discovered that there was a systematic method of attacking certain original propositions and have put it down as one of the red-letter days in my study of mathematics. In the high school I never received so much as a hint that there was any way but groping about. It was in the university that my attention was first called to Petersen's book, *Methods and Theories for the Solution of Problems*, which supplied a need I had long felt.

Surely every pupil will consider any method of intelligently attacking an

original as a great find, for no matter how much they may declare that they "hate mathematics," they all find pleasure in thinking out a proposition for themselves. It is usually misdirected or undirected effort which causes the wail we so often hear. The teacher's first concern should be to arouse interest in the pupil, to make him think of his geometry with pleasure, for "pleasurable efforts are the most effective." I have said *arouse interest;* perhaps it would be better to say *keep up the interest,* for I believe that interest in mathematics is the normal condition of children. How to hold the interest is not the subject under discussion, but sometimes a plain truth which you wish to impress may be dressed up in an attractive form. If you give the pupils some problem such as to find a means of measuring the height of a tall building or of finding the width of a river, the result will be more satisfactory than if you talk to them a whole hour upon the importance of the proposition about similar triangles. They like that sort of exercises and discover for themselves the importance of the proposition.

In order to gain facility in solving problems, subjects, or propositions which are fundamental should be dwelt upon and referred to sufficiently to make them part of one's working material. A pupil may be able to explain the two kinds of symmetry (the day that he has symmetry for his lesson) without it ever occurring to him to make practical application of it, or he might know how to demonstrate that "if two variables are constantly equal and each approaches a limit their limits are equal," but might never think of making use of it in an original demonstration if it were not called to his attention, directly or indirectly, that it is most useful in proving many other important propositions.

There are several simple loci which form the key to so many problems that every pupil should become familiar with them as with his a, b, c's Such are:

The locus of a point moving at a given distance from a fixed point.

That of a point at a given distance from a straight line.

The locus of a point equally distant from two given points.

The locus of a point equally distant from the sides of an angle.

The locus of a point equally distant from two parallel lines.

Pupils sometimes give up a problem before they have touched pencil to paper. They are conquered before they make a real attempt to conquer the problem. If diffident pupils can be prevailed upon to go to the board and get the figure before them, they are often surprised to find how simple a problem becomes which at first sounded difficult. A lack of confidence in their own ability has caused many a poor recitation. They will have gained what will be of lasting advantage if they learn not to give up a problem easily, being assured that "no effort is lost though at the time it may appear so." It might be of encouragement to tell them what the immortal Newton said; "I keep the subject constantly before me, and wait till the first dawnings open by

little and little into a full and clear light." A good motto for the teacher is found in the preface of a little book by William Spencer, father of the great scientist: "The inventive power grows best in the sunshine of encouragement. Its first shoots are tender. Upbraiding a pupil with his want of skill acts like a frost upon it, and materially checks its growth."

The questions of the possibility of a geometric construction of a problem is not often encountered by high-school pupils, for the problems presented to them are as a rule capable of solution. The pupil's attention should be called to such simple facts as that no problem can be solved in which a circle is required to fulfill four conditions, or a straight line three conditions; but in general they have no means of determining whether or not a problem can be solved. To the teacher, or to any other student of mathematics beyond that of the high school, it is an interesting question to determine when a problem can be solved by means of the rule and compass. Elementary geometry is not sufficient to determine this, for it has no general method; so we shall make use of algebra and analytical geometry. If a problem, however complicated, can be solved geometrically, it must be composed of the following operations, once or many times repeated: to draw a straight line through two given points and to describe a circle with given center and given radius. Each point is determined as the intersection of two straight lines — two circles or of a straight line and a circle. Expressed analytically, to find the intersection of two straight lines is to solve the equations

$$ax + by + c = 0$$
$$a'x + b'y + c' = 0.$$

The points of intersection of a straight line and a circle are furnished by the set of equations,

$$x^2 + y^2 - r^2 = 0$$
$$ax + by + c = 0.$$

A solution of either set of these equations will give only rational values, or values containing square roots. Since we know how to construct a square root with rule and compass, we may state the following important theorem: The necessary and sufficient condition in order that a problem may be solved by rule and compass, is that the quantities sought may be expressed rationally by means of given quantities and by square roots. Hence, to demonstrate that a quantity cannot be constructed with rule and compass, it is sufficient to show that the corresponding equation does not give values containing only rational quantities or square roots.

A few well-known problems will serve to illustrate:

Required to find the locus of all points equally distant from two given points.

If we take one of these points as the origin, the line joining them as the axis of x, and the distance between them, $2a$, which we may do without destroying generality, the equation of the required locus, $x = a$, is the equa-

tion of a straight line parallel to the axis of y, and the problem is capable of geometric solution.

Again, find the locus of the vertices of all right triangles having the same hypotenuse. This problem may be stated as follows: Find the locus of the point which moves so that the sum of squares of its distances from two fixed points is constant. The equation which expresses this condition is the equation of a circle, and again rule and compass may be used.

Let it be required to place a triangle in such a manner that each of its vertices lies upon one of three given circumferences. If one of the circles be removed, the locus traced by the vertex, freed from the given condition, is found by analytical methods to be neither a circle nor the limiting form of a circle — the straight line, therefore the problem has no solution.

The problem of Delos or of the duplication of the cube, expressed analytically, is $x^3 - 2 = 0$, where the edge is taken as the unit of length. The roots of this equation cannot be expressed by means of square roots nor by rational quantities; hence it is impossible to construct this problem with rule and compass.

The trisection of an angle may be made to depend upon the following problem: From a given point P in a circumference to draw a line which shall intersect the circumference in M and any given diameter in N, so that MN shall equal a radius. Leaving the diameter out of account, and considering only the point N, we find that the equation of its locus is of the fourth degree and represents the Limaçon of Pascal. The intersection of the diameter with this cannot be determined with rule and compass, so the problem lies without the scope of elementary geometry.

The application of this method some centuries ago would have saved hours of study for many a mathematician; however, we will not call it wasted time, for in geometry, as in alchemy, a search after the unattainable may lead to results more important than the object of search.

THE BIOLOGICAL CONFERENCE

REPORT ON ZOÖLOGY, BY PROFESSOR REIGHARD, OF MICHIGAN UNIVERSITY

In the discussion of zoölogy teaching, Professor W. H. Munson, of Hillsdale, presented a paper on the teaching of zoölogy in the secondary schools, attempting to answer the questions "what?" "how much?" and "how?" The paper was followed by discussion, which was led by Professor W. B. Barrows, of the Michigan Agricultural College, and in which Professor Jacob Reighard, of the University, and Professor Barr, of Albion College, took part. In reply to the question "what?" Professor Munson assumed, rather than distinctly stated, adherence to the plan of studying a limited number of animal types by the laboratory method. This plan is the one adopted in numerous recent books, such as Huxley and Martin's Biology, Marshall and

Hurst's Practical Zoölogy, Dodge's Practical Biology, and many others. This is the plan pursued in the beginning courses in most of our colleges, and barring the *exclusive* use of the text-book (a method condemned by every competent teacher), is the plan that may be most safely followed by inexperienced teachers. While it demands a certain technical facility on the part of the teacher and a certain range of knowledge, it is very far from necessitating any broad knowledge of the whole subject.

In answering the question "how much?" Professor Munson was inclined to make the number of types studied greater than is customary. To pass from a laboratory study of amœba alone to a discussion of the properties of protoplasm, seemed to him to be a dangerous approach to teaching induction from insufficient data. He would first study several types of protoplasm under a variety of conditions. How time was to be found for so diversified a laboratory course, without the sacrifice of thoroughness, was not made clear, nor was it pointed out that in such cases as the one cited above, the single laboratory type is meant to serve rather as an *illustration* of the general properties of protoplasm than as *proof* of their universal occurrence. A laboratory course of this sort furnishes *proof* enough of certain minor facts and processes, but only *illustrations* of general principles.

What Professor Munson had written in answer to the question "how?" had been so anticipated in the two botanical papers and in the discussion that followed them, that it was largely omitted from the paper as read. Briefly stated, the points insisted on were: (1) A careful training in observation, free from the influence of books, the work of others, or other "predisposing causes;" (2) an accurate record, written and pictorial, of the facts observed; (3) some training in the use of the facts in scientific induction.

In the discussion by Professor Barrows, of the Agricultural College, it was maintained that zoölogists should learn from the teachers of the languages and mathematics. The field of zoölogy is quite as extensive as any of these, yet zoölogical teachers commonly attempt to cover the whole of this field in a single brief course, while teachers of the languages are content to cover a very small fraction of the field in a similar course. It was argued that each zoölogist should limit his teaching to that part of the field with which he was most familiar. Thus, instead of attempting to cover the whole animal kingdom, he would spend his time upon insects alone, or upon molluscs alone, or upon some other limited group. The quality of the instruction would thus be greatly improved, and the study could be made to afford real training to the students. Professor Barrows here seems to have had in mind the teaching of systematic zoölogy, and his remarks should be thus interpreted. On the other hand, it is of course true that by the study of the structure and functions of selected types, the animal kingdom may be fairly well covered in a brief course, after the manner outlined by Professor Munson.

Professor Reighard, of Michigan University, called attention to the fact

that two sides of the subject had been so far brought forward; one the "biological," the other the systematic. He hoped that some adjustment might be arrived at, by which the work of the secondary school could be correlated with that of the college, and inquired whether a considerable part of the systematic work could not be relegated to the lower schools. He believed that the nature-study work of the primary schools could be so conducted as to make the pupils familiar with all the commoner animals of their neighborhood. Competent teachers could bring these animals (often living) into the schoolroom, and students would be interested in them and would easily become familiar with them and even with their scientific names. They would be eager to know of their habits and habitats. Thus a large fund of natural-history knowledge could be acquired with little effort and at a time of life when it would be most likely to make a favorable impression on the student. In the secondary school there could then be a course in the study of animal types, as recommended by Professor Munson. All of this presupposed well-trained primary-school teachers. If such a correlation could be brought about, it was believed that the student would reach the college prepared to take up advanced work. At present the college student must begin at the beginning. If systematic zoölogy is to be taught in the high school at all, the speaker favored a trial of the plan suggested by Professor Barrows, by which instruction would be limited to a single group — the subject becoming entomology, for instance, in place of zoölogy. He further favored a study of zoölogy from its physiological or economic side. The exclusive study of systematic or structural zoölogy he believed to be narrow and believed that more attention should be given to a broader study of the animal in all its relations — the physiological or oecological aspect of zoölogy.

Professor Barr, of Albion College, was unwilling that systematic zoölogy should be taught at all in the primary schools. He favored leaving the entire natural-history work of the schools in the hands of the botanists. His objection seems to have been rather against the formal systematic zoölogy of the books, than against the form of nature-study work recommended by the previous speaker. The latter form of work would aim merely at a familiarity with the members of the local fauna as individuals, introducing only so much grouping as could be made to readily suggest itself to the pupils themselves.

BOTANY — WHAT SHOULD BE TAUGHT? HOW MUCH? HOW? CHARLES A. DAVIS, ALMA COLLEGE, ALMA, MICH.

IN teaching botany in the high school at least two factors have to be carefully considered before all others, namely the pupils and the teachers. The pupils are of most importance. They claim our attention first and must be considered as we find them, not as we would have them, under ideal conditions. The average pupils of our high schools, on account of bad, or unwise, and

one-sided training, are usually in a mental condition that is worse than blank when they reach the grades where the elements of botany are studied, for their minds are already bent and twisted, and have become fixed in bad habits of study and thought. They are not as little children for their minds have lost the flexibility and elasticity of childhood and that vivid interest in the world about them which is so manifest in young children. I need not portray the deficiencies of the average pupil from the standpoint of the teacher of botany, for they are familiar to most of us from personal experience. Such as he is, we have him before us and we wish to give him as much benefit as possible, in an altogether inadequate time, by means of a course in botany. The ideal teacher could take this average pupil, and in a few lessons so arouse him, that he would soon become an eager student of botany, or, at least, would be so stimulated that he would get all the benefit which is expected from the course. But here also the factor is an average one, and it is an average over-worked teacher, often without a special interest in the science, and usually without any special training in it, or great knowledge of plants, who comes in contact with the class made up of average pupils. Often a third factor, perhaps equally important, comes into the problem, namely, a text-book. These, then, are the principal factors in the problem before us; pupils not fitted for the work they are to undertake, teachers who have no special preparation, and text-books suited to ideal conditions, all to be harmonized and worked out x equals something, in a period altogether too short for ideal teachers to teach ideal students the rudiments of a great science under most favorable conditions. In most cases, as we would expect under the conditions which we have been considering, the x of our problem proves equal to zero and nothing else. This is not the answer desired, but it is unquestionably the one we get in many, if not most, small high schools, and some larger ones. The reason for this is plain and may be summed up in a few words. The interest of the pupils is not aroused and they do the work assigned them because they are required to, and drop the study as soon as they are allowed to.

We cannot presuppose that the high-school pupil has any interest in technical botany, for the average boy or girl has no knowledge of the facts on which science is founded. Some of our pupils do have an interest, often a most superficial one it is true, in the flowering plants of their locality. They will often gather the more conspicuous blossoms and even know common names for some of them, and almost universally want to know the names of others. Here then, is a point at which we may make a beginning, and, even under adverse conditions, hope to accomplish something lasting. Hence I will say unhesitatingly, that we should teach our classes of beginners in the high schools, especially under existing conditions, the morphology of the flowering plants and how to find out the names of the plants, that is analysis. I would not have this the only work done, but I would advocate, and as much

more as is possible, but in ten weeks, or in twenty, which is often the limit of time devoted to the subject, we cannot do thoroughly much more than that. In doing this work, I would not if it could be avoided use books for the study of the organs, but have the class work wholly from specimens of the parts under consideration and teach from them, and I would not leave one set of organs until the various parts and relationships were understood. I would if possible have the members of the class understand from the beginning that plants are alive and that botany is the study of things that are living.

Botanically speaking this may be wrong, radically wrong, for it is beginning at the top of the ladder, to have beginners work on the most complicated vegetable organs and even have them work at finding the names of the highest plants, or, even, for the time being, make that the object of study. This latter plan is exceedingly abhorrent to the botanist, for he says, and perhaps truly, that classification is the least important, is of least interest, and has the least scientific value.

But to those of us who are teachers as well as botanists, there is another aspect of the case, especially if we are teachers before we are botanists, as should be the case if we are teachers at all. From the pedagogical side we see the matter in quite a different way, and that which seems radically wrong to the botanist, is both radically and theoretically right, for it has the broadest of foundations in the great underlying principle of all teaching, "from the known to the unknown." Most pupils know something of flowering plants and they are familiar with, and accustomed to the common types. They have an interest in them, or have had at sometime, and this may be aroused anew by a little judicious effort by the teacher. Thus we have two most potent allies, familiarity, and the pupils' interest.

To digress for an illustration drawn from personal experience: not long ago the writer was discussing before a class of beginners, fruits, and the food supply in them, and, asking for examples, some member of the class mentioned the potato. Having some potatoes at hand they were distributed and in a moment every one was alive with interest, while before only moderately good attention was shown to what was being said. The reason for the change was easily apparent, for the pupils thought they knew something about the potato and wanted to tell it, while they did not care to hear about the facts which were being told, for they had not reached the stage of knowledge where the facts had any significance. During the discussion which followed some very important botanical truths were developed, and the class came to the conclusion that the potato was not a fruit.

The first question that is asked by the average student, when he is shown a plant with which he is not familiar, is "What is it?" and until you tell him, he shows much interest. He is frequently interested in learning something about the habits of the plant after he has learned the name, but first he wants to know the name. It would seem that this very curiosity to know plant

names ought to be taken as an indication that it would be working along lines of least resistance to teach such pupils to find out the names of plant forms with which they are likely to come in contact, and later, when new questions arise, new lines of work suggested by them should be taken up. The method has certainly the least mental inertia to overcome in the pupil, and on that ground if no other, it should be abandoned only when pedagogical, not purely botanical reasons, are urged it. The collecting of plant specimens for making an herbarium is often an incentive to the study of plants in their native haunts which can and should be fostered to the great advantage of the student, and while, it is true, there is great chance for abuse in this, as in all other methods of class work, in any subject, many a botanist of today, has the good old-fashioned, herbarium of fifty or a hundred, poorly prepared, poorly determined specimens which he made when a boy, to thank for the faith that is in him, and even now remembers the pleasure he had in collecting it.

Pupils must be taught to see with their unaided eyes before they can profitably work with even the simple microscope, and this furnishes us with another reason why the study of the seed-bearing plants is likely to be more profitable to beginners in botany than that of any other group. The use of the compound microscope involves the loss of some valuable time from the very limited amount at the disposal of the beginner, and often it is much that is lost, for it takes the average pupil a considerable time even to learn to see with unaided eyes, and much longer to see intelligently with a compound microscope.

It would seem therefore, to be a mistake under conditions existing in our schools at present, to begin the study of botany by examining the protophytes first, and to follow that up by the study of other unfamiliar cellular and microscopic forms, for by the time the vascular and more highly organized plants are reached, the patience and interest of the pupils are exhausted, and while they have been introduced into a world that is new to them, it is one they did not care for and into which they will never penetrate again willingly.

It is also for reasons stated above, of very little use to spend much time in the study of the minute anatomy of the higher plants, or of vegetable physiology, for while the truths that are made plain by these departments of the subject are beautiful and full of meaning to more advanced students of botany, they mean nothing to the beginner, because he has nothing behind, with which to correlate such truths.

The writer does not advocate the entire omission of the study of minute structure and physiology from even the most elementary course in botany, but would urge rather that both be used to supplement the study of gross anatomy, as often as possible, but only as the need for such study is developed in the course of other work. When we have a course in botany beginning in the kindergarten, and ending in the university post-graduate courses, then we may, and undoubtedly will be able to have our students in the high schools

take up the study of the cellular plants with the highest profit, but until then experience is showing us that we should confine the work in elementary courses to flowering plants.

The question "how" can best be answered by experiment, for no two people can accomplish quite the same results in any given time or way. Botany should not be studied from books, but from plants, and one single plant, carefully studied may give work for a lifetime after the foundation for such work is laid. For beginners who start in midwinter, there is no better material for study than twigs bearing buds, in as great a variety as possible, and seeds, which may be studied by themselves or in connection with growing plantlets from seeds of the same sort. Leaves either dried or from exotic plants should be used to teach the many things that can be taught from leaves. This work, in connection with the study of roots and the winter forms of plants may be prolonged until spring. The pupils should be required to make careful drawings of all the forms which they study and to write full and accurate descriptions, which should be made comparative whenever practicable. During this period, and later as well, the necessity of using concise and exact language, of having exact knowledge before they write, should be enforced upon the pupils, and much valuable training may be had in this way, apart from purely scientific lines. When the season for the blooming of wild flowers comes, the members of the class should be instructed in collecting material for study, and if possible, the class should be taken into the field and taught there.

A word in regard to the text-book may not be out of place here. The chief defect of our text-books seems to be, that they are made for the botanists and not for our schools, that is, they are written by the best authorities, and are written, it may be unconsciously, with the thought of what the botanical world will say about them, rather than with the thought of what the needs of the schools are. The result is often books that are admirable as monuments of learning, but they are not for the schools. The text-book in botany should be used only as a guide, and if but a single page can be mastered by the class, that is all that should be used. It should be remembered also that facts should come before theories, and do in a normal course of development and students of botany should be allowed to acquire a certain number of facts before much of theory coördinating facts is given them. In closing, the writer would take occasion to urge upon teachers here assembled, the importance of making an effort to bring about such a change in the courses of study in our schools, that the study of plants and animals shall be made an organic part of the work in every grade from lowest to highest, and that these efforts be constant and unremitting until the end sought is accomplished. Then, and not till then, may the course which the botanist considers the ideal one be adopted successfully in the high school for the work in the lower grades will lead up to it by natural and easy steps.

Professor Spalding, of the University of Michigan, said in substance:

I do not care to discuss, as if we were engaged in preparing a school programme, the exact amount of work in this subject and the form that the daily exercises ought to take; the schools can be trusted to work out such details for themselves; what I do want to say, with all possible emphasis, is that botany, like any other science, will be well taught just as soon as trained teachers are appointed to teach it, and it will be poorly taught just as long as these are lacking.

It is so easy now to obtain instruction in the modern science of botany that there is no excuse for perpetuating the old order of things. One can get, in any one of fifty or a hundred universities, colleges, and normal schools, laboratory instruction that a comparatively few years ago could be had in hardly half a dozen institutions in the country.

Not only in the regular courses of our universities, but in easily accessible summer schools, facilities are offered, both in the morphological and physiological study of plant life, that many of the present generation of teachers were obliged to visit foreign laboratories to obtain. With all these opportunities brought to our very doors, there is no longer any valid reason why teachers of botany, any more than teachers of language or mathematics, should be unprepared for their work. As a matter of fact a new generation of science teachers is already on the ground, and their ranks are steadily filling with young men and women who are making the study of botany a very live thing. The trained teacher is coming, and the rest is sure to follow.

I find some practical difficulty in giving an explicit answer to the questions, "what?" "how much?" and "how?" but I should say secure if possible an entire year for botany in the preparatory school, but if only half a year is to be had make it a half a year of such discipline as the pupil can get in no other subject, a training of eye and hand and judgment, the develment of patience and all the laboratory virtues, and be sure to leave him at the end of the course, not with the self-approbation of one who has "collected fifty specimens" and has nothing else to do, but with eyes that have been opened, so that every living thing he meets asks him questions about its origin and relationship, and the meaning of its form, color, and structure. There is no royal road to all this, no text-book that is a sufficient guide; only the living teacher, who himself has found it, can show the way.

DIGEST OF DISCUSSION ON SUBJECT: "POLITICAL ECONOMY IN THE HIGH SCHOOL."—J. E. LAUTNER, PRINCIPAL CADILLAC HIGH SCHOOL

Any educational system is determined by the ideal of life that prevails among a people. The ideal of America is that of democracy, which aims at

the development of every individual. The food for this enlargement and enrichment of the individual is derived from various sources of human culture, as the Hebraic, the Helenic, the Roman, the Teutonic. The latter has given us (*a*) modern languages and literatures, (*b*) science, (*c*) a complex industrial system (due to use of steam). All of these elements of human cultivation are discharging their rich content into our secondary schools, except that of industry. Its culture and guidance value are as great as that of any of the other sources named, and hence ought to have a place in the high school. Moreover, all the serious problems which we are to solve are of an industrial character. The Renaissance freed men intellectually, the Reformation religiously, the French Revolution politically; it is the business of democracy to free men industrially, and to provide and to maintain equal opportunities for all individuals.

This ideal can largely be attained by the study in our high schools of no formal and metaphysical economics, but the subject-matter suggested by such terms as industrial history, the evolution of industry, the study of industry, etc. There are no adequate text-books on this subject for high school purposes. The new books should devote a large space to the history of inventions. The other leading phases of industry should all be presented in a historical and evolutionary way, rather than abstractly and analytically. Each phase should be so treated as to throw light upon current problems. The best results are obtained if the subject can be taught in the last year of the high school.